***Radio Technical Commission for Maritime Services***

1611 N Kent St, Suite 605

Arlington, Virginia 22209

[*www.rtcm.org*](http://www.rtcm.org)*hq@rtcm.org*

*Telephone: +1-703-527-2000 Telefax: +1-703-351-9932*

20 – 21 June 2018

**Plenary Meeting Summary Record**

**RTCM Special Committee No. 134**

**Recommended Standards: Integrity for High Accuracy GNSS-Based Applications**

 Time/Date: 9:00 AM – 5:00 PM, Wednesday, 20 June 2018

9:00 AM – 5:00 PM, Thursday, 21 June 2018

Location: SOGEI

Via Mario Carucci 99, 00143, Rome

Room TC04

The main objectives of the meeting were the following:

1. Review the Terms of Reference that formed SC-134
2. Determine initial/focused goals
3. Determine short and long-term technologies and extents covered by SC-134
4. Operating committee framework/processes
5. Determining partner and/or members of other organizations
6. SC-134 Membership items

Document Contents:

* [Chairman’s Executive Summary](#EXSUMM)
* [Meeting Summary Record](#SUMMARY)
* [APPENDIX 1: Meeting Attendance Record](#APP1)
* [APPENDIX 2: SC-134 Working Groups and Working Group Chairpersons](#APP2)
* [APPENDIX 3: Table of Open Committee Action Items](#APP3)
* [APPENDIX 4: Table of Closed Committee Action Items](#APP4)

**Chairman’s Executive Summary**

**Kendall Ferguson, Chairman of RTCM Special Committee No. 134**

* There was a presentation regarding the background of RTCM, its history and its evolution from a maritime specific organization to more general areas. For example, SC-104 initially developed RTCM 2.x for Safety Of Life At Sea (SOLAS), and because of its success promoting interoperability in a general sense for both maritime and non-maritime purposes, interested parties came together with RTCM to form RTCM 3.x (which is now greatly employed in land, air and sea).
* SC-134 formed as the result of a need indicated by many of its members; a need for a standard associated with Integrity of High-Accuracy GNSS safety of life applications.
* There were presentations on how RTCM operates, its officers, how its committees operate, its By-Laws, and its standards development policies.
* There was a presentation regarding some efforts already started within SC-104 related to Integrity of High-Accuracy GNSS safety of life applications, and this work now belongs with SC-134.
* There was much discussion regarding the technologies and the extent into those technologies that should be of concern to SC-134. Through several discussions in different topic areas, the committee determined an initial focus through the formation of 4 working groups, knowing that more may be formed in the near term.
* The committee decided to change the name of SC-134 to Integrity for High Accuracy GNSS-Based Applications so as to be in line with its initial focus. The committee agreed that it may, in the future, reach onto other areas: for example, the more inclusive PNT over GNSS.
* There were several presentations from participants that included areas of interest to SC‑134, some of which contained recommended areas of SC-134 focus.

### RTCM SC-134 Plenary Meeting

Rome, Italy

9:00 AM – 5:00 PM, Wednesday, 20 June 2018

9:00 AM – 5:00 PM, Thursday, 21 June 2018

## Meeting Summary Record

1. **Welcome and Opening Remarks – Roberto Capua, SC-134 Vice Chair**

Welcoming remarks by the Director of Sogei, Fabrizio Rauso, Head of People, Organization & Digital Transformation, a division of the Ministry of Finance for Italy.

Roberto then covered meeting logistics. Lunch at 12:40 to 13:40. Attendees were requested to sign in on the Sogei attendance list covering privacy rules.

Sogei arranged for interested attendees to go to dinner together.

1. **Introduction of Attendees – Kendall Ferguson, SC-134 Chair**

Kendall introduced himself and then asked each attendee to introduce themselves. At the beginning of the meeting, there were about 22 people present and another 11 people on the Skype call-in.

1. **Goals and Agenda – Kendall Ferguson, SC-134 Chair**

Kendall thanked all participants for coming to the meeting. He discussed some of the RTCM business aspects such as Bob Markle serving as the interim president. He went on to explain that committee documents are distributed by the RTCM president; they do not come directly from Kendall. Kendall explained how the meeting agenda works. The agenda is Tentative meaning that it can be adjusted to accommodate the participants’ schedules.

A question was asked about committee meeting documents. How can they be accessed? Kendall stated that documents are distributed during the plenary sessions and then also posted to a website for global review.

1. **SC-134 Establishment – Kendall Ferguson, SC-134 Chair**

Kendall gave a presentation on the background and evolution of the SC-134’s formation (see RTCM Paper 086-2018-SC134-005). The remainder of this section captures a summary of that presentation and the conversations that ensued.

RTCM was created in 1947 as a U.S. State Department Advisory Committee. Now it is an international non-profit, scientific, professional and educational organization.

The Board of Directors (BoD) is comprised of people with a wide range of expertise. There is one full time employee and three part-time interns. Most of RTCM funding comes from membership annual dues.

Special Committees address in-depth Radiocommunication and Radionavigation Areas of Concern. The Special Committees develop and publish RTCM standards. A list of the 16 currently active committees was displayed. Though the original work of RTCM was primarily maritime focused on Safety of Life at Sea (SOLAS), non-maritime industries recognized interoperability success and began requesting more standards such as RTCM 3.x and NTRIP. Now, numerous sectors such as surveying, construction, agriculture, etc. rely on interoperability standards in modern code and carrier-based real-time applications.

There is a need for common integrity standards for high-end, high-accuracy applications. The question has been asked, “Why a new Special Committee. Should this effort be a part of the SC-104 effort?” Kendall stated that integrity subject matter is too large for SC-104 alone. It requires more diverse subject matter experts (SBAS, rail, automobiles, highways, etc.).

SC-134 was created with the expectation that SC-104 have adjacent meeting dates and venues since many of the members will be the same. The next SC-104 meeting will be in Frankfurt (October 18-19) in conjunction with Intergeo. Several scheduling possibilities were presented for the next plenary session for this committee in the same timeframe as Intergeo.

Papers and presentations related to the work of SC134 will be posted to a website. SC-134 Papers Page: [http://rtcm.info/SC-134/](http://rtcm.info/sc134/)

A question was raised about security of the website. SC-134 papers will not be hosted on Sharepoint. Options for security are being analyzed and some protocol will be implemented in the coming months.

A question was raised about membership terms. Kendall asked that this topic be tabled for later in the agenda.

Another item of interest that was covered is the file naming nomenclature. Kendall reviewed the Standards Development paper that formally covers the topic.

1. **SC-134 Terms of Reference – Kendall Ferguson, SC-134 Chair**

Kendall presented the “Terms of Reference” (TOR) document (see RTCM Paper 188-2017-SC134-001) that was presented to the RTCM BoD for the establishment of this Special Committee. A ToR document defines the general scope of the work to be performed and why the effort is vital. As a committee evolves, the scope of work may change, but the ToR does not. The ToR is used only to validate the creation of the Special Committee and loosely define the initial scope of work to be done.

A question was raised about point 2.a.ii: The word “architecture” seemed to cause a bit of concern. The term was architecture, as used therein, is meant to follow a loose definition in that such an architecture may, as deemed by the committee, may range from concepts to well defined algorithms and approaches.

Another concern was raised that the ToR prescribes quite a bit for the server side with almost nothing on the rover side. This seems backward compared to the SBAS approach. Kendall suggests that the ToR could be modified to reflect the intended direction of the committee including clear statements about rover side implementations.

Another question was raised about participation amongst various sectors that might not be included in this group. Kendall replied that it is up to the membership to recognize gaps and encourage participation.

A question was raised about high-accuracy versus all positioning at any accuracy levels. This discussion was tabled given a later agenda item on this very topic.

The question was raised about using the term “GNSS” as it relates to the name of the committee. Is this a limiter to the work of the committee? Will the committee consider other positioning techniques? And inputs from other sensors? This discussion was tabled given a later agenda item on this very topic.

A question was raised about the meaning of the word “monitoring.” Kendall agreed that this is a topic that needs to be discussed and is the subject of a later agenda item of this meeting.

Integrity. Is it tied to authentication? Kendall agrees that this should be part of the discussion. Spoofing is another related topic.

“Integrity risk.” How should this be budgeted? PNT is just a piece of the equation and it should be agnostic to the technology being used.

A question was raised about the Working Group of SC-104 and its progress to date. The committee was notified that at the last meeting of SC-104 in China, the IM WG was discontinued since this committee was formed to deal exclusively with the topic without distraction. All of the work that was done in SC-104 WG will be brought by Roberto to this new committee.

Dmitry Kolosov raised the importance that there needs to be tight coupling of work between RTCM SC-104 RTCM 3.x WG and this committee. At some point, the work of this committee will need to be handed off to the version 3 WG.

Kendall mentioned that each Special Committee can define its own processes, for processes other than those defined already by the RTCM Board of Directors (such as those processes detailed in the RTCM By-Laws and the RTCM Standards Development Policies). The processes or rules followed by this committee may be quite different from those of SC-104. For instance, where is the main work to be done? Are Working Groups (WG), for given subject matters, were the main work done is done (with final approval through plenary voting)? In the plenary session? Online via email or WebEx?

1. **Review of SC-104 Integrity WG Concepts – Roberto Capua, SC-134 Vice Chair**

SC-104 WG about Integrity Monitoring has been replaced by Special Committee 134. Roberto outlined the progresses made to date by the previous committee and a vision on how to move forward (see RTCM Paper 087-2018-SC134-006). A summary the presentation contents and associated conversations follow.

Objectives were to define a roadmap for IM systems, messages and protocols development, to define a generalized architecture for IM, and to address Accuracy, Availability, Integrity, Continuity needs for Aviation, Rail, Automotive, Geodesy/Surveying and Maritime are represented.

IM definitions: Integrity, alert limits, time to alert, protection level and integrity risk.

Integrity requirements are usually expressed in terms of probability of Hazardous Misleading Information (HMI) during a predefined operation time interval.

Several graphs were presented that will be included in the meeting documents.

An Application Specific Example was provided regarding Automotive Integrity. Included requirements are lane keeping, sensor fusion, GNSS Mfg. High-Definition mapping, safety compliance and autonomous vehicle support. An example of generalized architecture showed how Application Specific Control Centers was one of the concepts to be taken into account for developing single applications.

Roadmap of Integrity Monitoring messages: Application Requirements Review, Basic Integrity Monitoring, Advanced Integrity Monitoring, CRAIM-PPP-CRAIM, Migration to MSM.

Roberto would like to see a web portal where all testers can access data and share raw data for testing.

Key points for SC-134: 1) Application specific safety requirements review. 2) Architecture and interfaces among augmentations infrastructures, application providers and users. 3) Roadmap definition. 4) Distributed test-beds setup by applications for interoperability tests.

Again, the point was raised that this work should not necessarily be GNSS centric and instead of referring to base/rover, the discussions focus on PNT regardless of the sensor being used.

A discussion ensued regarding interoperability requirements. Kendall replied that this committee may choose to select interoperability requirements on a case by case basis. Some of the technicalities can be verified through simple coding/decoding while other messages may require that two different brands interoperate in real field tests. Or, a certification body could be contracted to perform the interoperability tests themselves.

A question was asked regarding the application domains; will this committee work through mission critical verticals such as the military, governmental and safety? Kendall replied that this will need to be a decision made by the committee.

A document produced several years ago that could provide a suitable framework to begin with: <https://www.iogp.org/bookstore/product/guidelines-for-gnss-positioning-in-the-oil-gas-industry/>

Other questions were raised in terms of compatibility. Do interoperability and compatibility mean the same thing? And, what about other players that may be involved in integrity topics but are not a part of this committee? Developing answers to these questions are to be part of the initial SC-134 work. Certainly, getting other sector/expertise involvement needs to be done and members are encouraged to make connections and inform them of SC-134.

The issue of speed monitoring should also be considered. Most of the discussion is centered on PNT, but speed is also an important consideration.

The key point of “Application Specific Safety Requirements” was discussed. Since each vertical market will have their own requirements, the work of this committee should initially be generic enough to allow these verticals to fit their application into the standard. Alternately, these entities should be involved in the standards development.

1. **Existing RTCM Processes – Kendall Ferguson, SC-134 Chair**

A member organization gets one vote in committee decisions and one vote on standards issues. Kendall reviewed the rights and privileges of being an RTCM member. He paged through the RTCM Bylaws document and highlighted key points (see RTCM Paper 225-2013-BD-508). Kendall also paged through the Standards Development Policies (RTCM Paper 226-2013-BD-509) pointing out a generalized description of its contents.

Kendall went on to explain how the voting process works. These are CDV’s (Committee Draft Votes). CDV’s require a 20% quorum of the member organization represented on the SC membership list. The CDV requirements are legalistic parameters formulated by the RTCM BoD. Working group requirement are less formal usually though specific rigors can be required.

Abstaining from a CDV allows the committee to count the abstaining vote against the 20% quorum requirement. Therefore, it could be vital for a member organization to vote with an Abstain versus not participating in the vote at all even if the topic has no bearing on their interests.

Non-RTCM members are not allowed to participate in CDV’s. However, since this session was a kick-off meeting, there were many participants present that are not currently members of RTCM. Therefore, for this meeting only, Kendall suggested that all attendees present be allowed to vote on committee issues and decisions. Non-members can be invited to attend one or two meetings, but beyond that, participants are required to be part of a member organization. Membership in RTCM allows access to all Special Committees.

Important questions to be addressed in the next several meetings are:

* What is the process for developing SC-134 standards?
* Will WG’s be formed to take over specific topics (as is done with SC-104)?
1. **Patent Disclosure – Kendall Ferguson, SC-134 Chair**

Chairmen of Special Committees will ask, at an appropriate time in each meeting, whether anyone has knowledge of their own or other organizations’ patents, including published pending patents, the use of which may be required to practice or implement the standard being considered. The fact that the question was asked shall be recorded in the meeting summary record, along with any affirmative responses.

Kendall read this statement verbatim to the plenary group. At the conclusion, Kendall asked if there were any patents of concern related to this body. There were no responses.

1. **SC-134 Technologies and Extent – Kendall Ferguson, SC-134 Chair**

Though listed with its own bullet, the next two agenda items are closely related and should be considered together.

Kendall suggested that inputs be collected during the plenary session. These can be recorded and processed for further dissemination in the form of a questionnaire.

Washington Ochieng (Imperial London College) believes the point of beginning is the application layer, especially critical infrastructure. He suggests that there are 13 to 15 of these critical infrastructure application layers and some of them have already been addressed under other standards (such as RTCA). These do not to be addressed with the urgency that other topics that are not standardized yet but still considered critical infrastructure. (These include space, transportation, finance, economics, water, surveying, chemical, nuclear, telecom…)

Fergus Noble (Swift Navigation) agrees that the application layer is the place to begin the work, but to achieve early success, the ambition must be narrowly defined with focus also on what will NOT be covered.

What kind of positioning modes are being considered for Integrity Monitoring? GNSS RTK, PPP, PPP-AR, etc. Each mode will likely require its own Integrity Monitoring parameters.

There was good discussion about the sequence in which the work should progress.

It was pointed out that we should talk about PNT requirements. Alessandro Neri emphasized the fact that numbers depend on the way a methodology computes the Integrity parameters. Salvo Sabina pointed out that that are two ways to proceed: driven by technology or driven by user needs.

It was suggested that meeting the user needs should drive this development. Varying levels of performance are required, and it is most important to make sure that the work of the committee is meeting the needs of the end-user. Start from user requirements at the macro level. Then an iterative approach can be carried out. Incremental improvements can be made increasing end-user performance levels.

Erik Vigen (Fugro) believes that it is possible to create a framework that is not overly complex covering most end-users requiring precisions from 1 centimeter up to the system level precisions of 12 meters. Fergus proposed that the most complex and rigorous requirements come from the automotive industry. If these needs can be met, it should cover most of the other needs throughout the other vertical industries.

Dmitry Kolosov (Topcon) countered and stated that the most complex applications should not be pursued first. If there are 15 different critical infrastructures that need Integrity Monitoring, it would be best to find the commonalities amongst all of these and work towards standardizing the common elements first. Therefore, we should start identifying common needs.

Washington spoke to the idea of focusing on “Protection Level (PL)” messages. They have to contain data needed for computing the PL. He stated that this is the main work to be done by this group.

ISO has already created dependent “Smart City” standards that might be used in the formulation of this group’s work. Gathering more information about these smart cities for review by the committee members has been recorded as Action Item number 4 and will be assumed by Dr. Mireille Elhajj (Imperial College London).

Kerry Greer (Globalstar) asks if there will be liaisons with other organizations that are working in parallel on related activities. It was noted that this is the topic of a later agenda time (which is later in this report).

It was suggested that Cloud processing should also be included in these discussions. Some present question whether this segment also requires standardization.

Kendall summarized the fact that the committee needs an initial work plan. Roberto has agreed to lead this effort with members that are interested. A general mailing will be sent to all parties that have expressed any interest asking for ideas, inputs and recommendations to create this work plan. This has been recorded as Action Item number 5. Fergus asks that this initial plan include high level information such as whether corrections are required at all, manufacturer algorithms that may need to be implemented to support the standard. Erik brought up the issue of authentication: asking questions such as “Is the correct information being delivered to the correct rover type?” and “Is the rover entitled to the corrections it’s receiving?”

Salvatore Sabina that terminology is important. Some terms (e.g. Integrity Risk and Alert Limit) are related to specific applications and can have no sense in others (e.g. for the case of Rail). Furthermore, the parameters range and relevant importance depends on the application environment. For instance, in aviation multipath is not so relevant while for rail multipath and interferences are the main features. Augmentation cannot tackle this point, that are at On-Board Unit level. It has been agreed that a classification is needed for identifying common parts.

Longer term, Kendall suggests that Integrity Monitoring standards that are created by this group might be handed over directly to SC-104 for standardization within a reserved message number range.

Washington addressed the point that attention has to be put on the single or multiple failure aspects. RAIM deals with single Failure, but in the automotive sector multiple failures are very common.

Erik raised the point that data security and Authentication are aspects to be analyzed.

Alessandro Neri underlined the importance of automotive applications, sensor fusion, and the assurance aspects are relevant. Furthermore, crowdsourcing, as a mean of sharing information among user receiver, has to be taken into account into our analysis.

Within the framework of cooperative collision avoidance, speed accuracy has to be taken into account and exchanged.

1. **SC-134 Initial Focus – Kendall Ferguson, SC-134 Chair**

See notes from item above.

1. **SC-134 Short-Term and Long-Term – Kendall Ferguson, SC-134 Chair**

See notes from item above.

1. **SC-134 Specific Framework/Processes – Roberto Capua, SC-134 Vice Chair**

Roberto framed the key points in a summary statement and then opened the floor for comments. The main notions behind his framing the key points are that RTCM Special Committees can define their own processes, for processes other than those defined already by the RTCM Board of Directors. Kendall brought up the idea of SC-104 style Working Groups may be an effective method to get committee work accomplished. He indicated that there are other possible models as well.

Washington Yotto Ochieng presented a couple of slides outlining (see RTCM Paper 088‑2018-SC134-007) his vision beginning with National infrastructure applications: 1) Chemicals, Civil Nuclear; 2) Communications and Defense; 3) Emergency Services; 4) Energy, Finance, Food; 5) Government and Health; 6) Space Transport, Water; and 7) Surveying, Location Based Services.

Within these applications the committee needs to understand or decide about required performance levels; understand the value chain and service level, classifications, technologies, vulnerabilities (threat scenarios).

Integrity at both server and user side is essential. Flexible failure detection and exclusion models. Flexible protection level computation models. Data message content and format. Generalized, flexible and expandable functional architecture. Must not be too prescriptive which can stifle innovation.

Testing is a challenge for very low percentile requirements. Combination of analysis and demonstration. Must be compliant with certification/approval requirements.

Kevin Sheridan (Veripos) inputs that the initial focus at least should be centered on GNSS. Washington adds that this might be a good approach to push the GNSS technology as far as it’s capable so that the limitations are clearly understood. Standards could be created which are centered around GNSS with the flexibility to add other technologies.

Aleš Filip (University of Pardubice) speaks that in tandem with Integrity Monitoring, reliability must also be considered. He referenced another standard that has already been written that could be incorporated within this committee’s work. Roberto added that this existence of standards that are already in place should be considered for inclusion where appropriate which builds upon the work already accomplished by other groups.

Marco Brancati (Telespazio) brought up the topic of 5G satellite-based standards that are being developed and could impact the work of this committee.

Alessandro Neri states that hybridization is the future of Integrity Monitoring. Fergus adds that repeatedly, the two industries that keep being discussed are automotive and rail, so this should be the topics pursued while looking for other verticals that may not have yet been considered.

Kendall asks that three or four topics and groups be formed at this meeting so that work can begin and that some progress made. Kerry asked what the expectations are of these groups for the next meeting. Kendall replied that since all attendees are volunteers with other priorities at times, hard deadlines are difficult to enforce and sometimes not realistic.

Roberto asks who is interested in working on automotive. Respondents were: Fergus Noble, Alessandro Neri, Marco Brancati, Frank Takac, Kevin Sheridan, Elisabet Lacarra Arcos, Washington Ochieng, Lance DeGroot, Marcus Brandl, Chris Hide, Aleš Filip, Mireille Elhajj, Shaojun Feng, Alexei Zinoviev & Kerry Greer (agreed to be group facilitator).

Roberto asks who is interested in working in rail. Respondents were: Washington Ochieng, Lance DeGroot, Alessandro Neri, Hui Liu, Elisabet Lacarra Arcos, Alissa Ioannone, Aleš Filip & Salvatore Sabina (agreed to be group facilitator).

Roberto asks who is interested in finding out about other applications that may be in the committee’s future that are not rail and automotive. Respondents were: Erik Vigen, Washington Ochieng, Elisabet Lacarra Arcos, Kevin Sheridan, Shaojun Feng and Roberto Capua (agreed to be group facilitator). A point rose about the workload to be facilitator of two Groups. A possible change of facilitator to be discussed.

Roberto asks who is interested in learning more about Harmonization of Requirements and Metrics. Respondents were Salvatore Sabina, Fergus Noble, Alexei Zinoviev, Washington Ochieng, Aleš Filip, Shaojun Feng, Elisabet Lacarra Arcos, Chris Hide, Marco Brancati & Roberto Capua (agreed to be group facilitator).

1. **Possible SC-134 Name Change – Kendall Ferguson, SC-134 Chair**

One suggestion was to drop the word “monitoring” from the name. A question was raised as to why “high precision” needs to be included? Another comment was regarding some ambiguity pertaining to “high precision”. It was suggested that if this expression is kept, a word like “application” should be added. Washington raised other concerns about using the word “integrity” which is very narrow, so another attendee suggested the word “safety.” Fergus disagreed with this line of reasoning. Dmitry pointed out that the main technology focus of the discussions in plenary sessions has been GNSS. Elisabet would like to keep the term “High Precision” in the name.

The current name as presented in the Terms of Reference is: “Integrity Monitoring for High Precision Applications”

Kendall asked the question if anybody in the room would be offended if the word “Monitoring” were taken out. There were no objections to this.

List of possible names considered included: “Integrity for High Precision PNT Applications”, “Integrity for High Precision GNSS-based Applications”, “Integrity for PNT Applications”, and “Integrity for High Accuracy GNSS-Based Applications”

Final decision – New name for the committee is: Integrity for High Accuracy GNSS-Based Applications

1. **Interfacing with other standards bodies – Roberto Capua, SC-134 Vice Chair**

Roberto Capua gave a presentation entitled “Interfacing with Regulation and Certification Bodies” (see RTCM Paper 089-2018-SC134-008). A summary the presentation contents and associated conversations follow.

Within each domain, there are a variety of standards bodies. A “GNSS Integrity Cross-Table” was presented showing different organization that may feed into this committee’s work such as RTCA, ISO, IEC, ETSI, IALA, 3GPP, EURO CAE, ARAIM WG C, SAE… Within these organizations, the appropriate related standards and possible liaisons need to be identified. These activities should occur at the working group (WG) level; each WG should begin listing the relevant standards that affect their domain. Care must be taken to not cause conflicts with these other organizations. Consideration should also be given to the order in which these organizations are engaged. There is likely a priority that should be established for contacting these groups. Additional activities to be considered by the WG’s include the exchange of recommendations concerning data contents completeness for Test-bed setup and for facilitating application specific certifications.

Regulatory bodies include: FAA, National Aviation Authorities, FRA, ERA, National Railways Authorities, Rail Safety Authorities, Regional Certification bodies, Ministries of Transport, Highways Authorities, IMO, IALA, National Mapping Agencies and Geodetic Agencies.

1. **Proposed Globalstar Contributions – Kerry Greer, Globalstar and Sam Pullen, Stanford University**

Kerry Greer gave a presentation entitled “Key Issues for RTCM SC-134 and Proposed Globalstar Contributions” (see RTCM Paper 090-2018-SC134-009). A summary the presentation contents and associated conversations follow.

Kerry began with a brief introduction of his company Globalstar and how they may be able to contribute to the work of this committee. Dr. Sam Pullen of Stanford University has been hired by Globalstar as a consultant and took over the presentation.

Their motivation is to support high-integrity vehicle applications. It is desirable to have additions to existing message content and development of flexible protection level equations. Make use of experience gained in RTCA development of SBAS and GBAS. These are the areas (at least) where Globalstar intends to contribute to the work of SC-134. Sam Pullen would like to get a standard that allows the implementer to innovate within the framework of RTCM.

Additional RTCM message content that is needed to support high integrity application are: Overbounding error standard deviations (not just best estimates), Bounding error biases, Prior fault probabilities (of GSS ranging sources and augmentation systems) and Emergency “do not use” messages to meet short times to alert (TTA’s)

Rather than building fixed (assumed) prior fault probabilities into standards, these should be broadcast so that they can be modified as needed. Prior fault probabilities include: Single-satellite fault probabilities for each supported GNSS constellation, constellation correlated fault probabilities for each supported GNSS constellation and fault probabilities for PPP/correction parameters provided by augmentation system.

Protection level equations translate range-domain error bounds and fault probabilities (after corrections from augmentation system) into position-domain error bounds at the desired integrity probability. This is based on the user’s own GNSS satellite geometry and the user’s own models for local errors and fault modes.

Stated in summary – The objective for SC134 should be to develop a standardized format for protection level calculations that can be used by many different implementations. And to broadcast integrity information which supports protection-level calculations while having each user take responsibility for his application of it. Additional integrity related information in RTCM messages are needed. Development of a flexible framework for user protection level calculations and protection level development would be based upon the information provided in updated messages types and protection level development that would support many different user implementations. A theory concerning protection levels associated with dual frequency has been described and should be considered by SC-134.

Sam will be presenting a paper at the ION conference in September in Florida. Kendall asked if he would be willing to drive up to the RTCM conference which is coincidental with the ION conference.

1. **High Integrity GNSS Location and Navigation Services for Connected Vehicles and Autonomous Vehicles – Alessandro Neri, University of ROMA TRE**

Alessandro Neri gave a presentation on “High Integrity GNSS location and navigation services for Connected Vehicles and Autonomous Vehicles” (see RTCM Paper091-2018-SC134-010). The remainder of this section captures a summary of that presentation.

Autonomous driving technology requires positioning accuracy and integrity. No individual technology can currently meet these requirements anywhere, anytime and under any condition requirements. Sensor fusion is considered as the go-to-solution for the development of fully autonomous driving technology. GNSS is an element of a sensor fusion based navigation system that also includes LIDAR/RADAR, inertial sensors and cameras.

Several use cases were presented including eCall, the European Regulation concerning emergency call for automotive, intelligent speed adaptation, cooperative collision avoidance, high density platooning, automated overtake, cooperative awareness/ traffic hazards warning, road hazard warning, vulnerable road users discovery and dynamic emergency lane management. Presentation posted to the website elaborating on all of these topics.

A two-axis chart was shown comparing degrees of automation against degrees of cooperation. Automated Highway Systems had the highest requirements for both of these.

Regarding the Cooperative Overtaking Scenario, an example was cited how information from the automobile’s tachometer could provide better and more robust performance levels than GNSS.

A graph showing six different levels of automation was shown: 0 = No automation. 1 = Driver assistance. 2 = Partial automation. 3 = Conditional automation. 4 = High automation. 5 = Full automation

The candidate solution for automotive reference architecture was derived from the European Project for the Rail sector named RHINOS. Reference infrastructure for rail could be used also for roads, taking into account that often roads are proximal (even parallel, like in Italy) to the railways.

1. **Main Rail Performance Requirements related to GNSS Positioning – Salvatore Sabina, Ansaldo STS**

Salvatore Sabina gave a presentation regarding their rail related work (see RTCM Paper 092-2018-SC134-011). The remainder of this section captures a summary of that presentation.

Location principles of trains were described as the estimated position of the train’s front end in relation to the last reference location. Detection of the measurement error of the physical balise were also described. Two use cases with high precision and high integrity were presented. The vision of the innovative solution based on the concept of a virtual balise detected by position computed by the PNT functional block (such as GNSS) was shown. Performance requirements must be realized when using GNSS-based PNT. Other related critical requirements include security. CENELEC EN 50159 was referenced. Security must be addressed at the system level based on the signaling properties. Track Area Survey was discussed. Track areas need to be classified as suitable or not suitable for locating virtual balises and must meet the ERTMS interoperability requirements. A standard track area classification process and procedures must be defined and used.

1. **Certification and Safety Acceptance process for GNSS-based ERTMS/ETCS and other railway high-safety integrity systems – Aleš Filip, University of Pardubice**

Aleš Filip gave a presentation concerning GNSS for the European Railway Traffic Management System (ERTMS) and European Train Control System (ETCS); see RTCM Paper 093-2018-SC134-012. The remainder of this section captures a summary of that presentation.

Virtual balises may be preferred over physical balises due to costs. High safety and dependability requirements for ERTMS must be met. Therefore, it is necessary to pass certification and safety processes. The approval process requires at least Safety Case and Assessment Report. Verification and Validation (V&V) and Safety Case elaboration according to CENELEC safety standards. Common Safety Method for Risk evaluation and Assessment (CSM-RA) harmonizes Risk Management Process, enabling the introduction of Cross-Acceptance of Risk Assessment Process. The aim of the European railway authorities and European railway industry is to develop interoperability railway systems based on common regulations. Cross-acceptance of Safety Approvals for sub-systems and equipment by the different national railway authorities is essential. A generic Product Safety Case should include: Generic description of railway SBAS safety applications, SBAS suitability analysis and the identification of all gaps in safety provisions.

1. **Summary of Hexagon’s activities and plans in Safety Critical High-Precision GNSS – Lance DeGroot, NovAtel**

Lance DeGroot gave a presentation concerning Summary of Hexagon’s Plans in Safety Critical High Precision GNSS; see RTCM Paper 094-2018-SC134-013. The remainder of this section captures a summary of that presentation.

NovAtel and Veripos jointly develop, with NovAtel on the client side and Veripos mostly on the server side. Current focus is on Automotive Applications. Enabling lane level accuracy using GNSS. Also interested in other applications such as UAV, Agriculture, Mining and Rail. PPP-RTK is the proposed technology. NovAtel has experience with safety critical GNSS through the WAAS and EGNOS programs. Aviation RAIM techniques must be translated into the land GNSS use cases. Systems must be designed to keep integrity risk very low, less than 10-7 / h.

1. **Potential SC-134 Membership Dues – Kendall Ferguson, SC-134 Chair**

Kendall showed a slide with the RTCM Standard Dues (See RTCM Paper 095-2018-SC134-014). There are four levels of membership: Sustaining @ $2700 USD per year. Standard member @ $2000 USD, Small member @ $850 USD and Individual (retired person) membership @ $175 USD. All of these amounts are yearly dues. During RTCM BoD meetings, yearly dues are reassessed. Dues are the primary source of funding. Other sources of funding, and which are smaller, include the annual meetings, documentation and charitable donations.

Kendall believes that there is potential for this committee to grow quite large. Along with this, there is the potential for higher clerical support needs. Therefore, it may be required that participation in this SC could have higher costs.

1. **Next Meeting (date and venue) – Roberto Capua, SC-134 Vice Chair**

Intergeo is in Frankfurt October 16 – 18 (Tuesday through Thursday). RTCM SC-104 is meeting in conjunction with this conference on the 18th and 19th (Thursday and Friday).

The committee agreed to hold the next SC-134 meeting on Monday and Tuesday, October 15 and 16. In order to assist European travelers, it was decided to begin Monday’s meeting at 11:00 AM to allow Monday morning travel possibilities to the meeting. Tuesday’s session will begin at 9:00 AM.

1. **Other Business – Roberto Capua, SC-134 Vice Chair**

Roberto asks if, after the Working Group (WG) establishment, a working plan should be created, and if it needed at this time. Kendall suggests that “milestones” with or without deadline could be assigned. It was agreed that each working group chair should establish the work plan they feel best to accomplish the work in front of them. Therefore, Action Item 5 assigned to Roberto, to develop a work plan was cancelled.

1. **Meeting Action Items Review – Kendall Ferguson, SC-134 Chair**

This list was reviewed.

**APPENDIX 1: SC-134 Meeting Attendance – 2018 June, 20 & 21**

| **✓** | **Name** | **Organization** | **Phone/E-Mail** |
| --- | --- | --- | --- |
| ✓ | Kendall Ferguson | Sapcorda | +1-540-446-8982kferguson@rtcm.org |
| ✓ | Roberto Capua | SOGEI | +39 0650 253 428rcapua@sogei.it |
| ✓ | Joe Sass | Spectra Precision | +1 909 553 5582joe\_sass@spectraprecision.com |
| ✓ | Salvatore Sabina  | Ansaldo STS | Salvatore.Sabina@ansaldo-sts.com |
| ✓ | Andrea Stuerze | BKG | andrea.stuerze@bkg.bund.de |
| ✓ | Elisabet Lacarra Arcos | ESSP SAS | Elisabet.Lacarra@essp-sas.eu |
| ✓ | Francesco Lilli | FCA - Centro Ricerche FIAT (Online) | francesco.lilli@crf.it |
| ✓ | Marco Darin | FCA - Centro Ricerche FIAT (Online) | marco.darin@crf.it |
| ✓ | Erik Vigen | Fugro | e.vigen@fugro.com |
| ✓ | Jannes Wuebbena | Geo++ | jannes.wuebbena@geopp.de |
| ✓ | Martin Schmitz | Geo++ | martin.schmitz@geopp.de |
| ✓ | Ken Harima | Geoscience Australia (online) | ken.harima@rmit.edu.au |
| ✓ | Kerry Greer | Globalstar | Kerry.Greer@globalstar.com |
| ✓ | Washington Yotto Ochieng | Imperial College London | w.ochieng@imperial.ac.uk |
| ✓ | Dr Mireille Elhajj  | Imperial College London | m.el-hajj11@imperial.ac.uk |
| ✓ | Frank Takac | Leica Geosystems | Frank.Takac@leica-geosystems.com  |
| ✓ | Lance DeGroot | NovAtel | lance.degroot@novatel.com |
| ✓ | Alexei Zinoviev | NTLab (online) | alexei.zinoviev@ntlab.com |
| ✓ | Shaojun Feng | QianXun SI (online) | shaojun.feng@wz-inc.com |
| ✓ | Ilaria Martini | RHEA GROUP (online) | i.martini@rheagroup.com |
| ✓ | Fergus Noble | Swift Navigation | fergus@swift-nav.com |
| ✓ | Marco Brancati | Telespazio | +39 335 876 7156marco.brancati@telespazio.com |
| ✓ | Alissa Ioannone | Telespazio | Alissa.ioannone@telespazio.com |
| ✓ | Kevin Sheridan | Terrastar | Kevin.sheridan@terrastar.net |
| ✓ | Dmitry Kolosov | Topcon Positioning Systems | dkolosov@topcon.com |
| ✓ | Markus Brandl | Trimble Terrasat GmbH | markus\_brandl@trimble.com |
| ✓ | Chris Hide | U-blox | Chris.Hide@u-blox.com |
| ✓ | Aleš Filip | University of Pardubice (Czech Republic) | Ales.Filip@upce.cz |
| ✓ | Alessandro Neri  | University of ROMA TRE | Alessandro.neri@uniroma3.it |
| ✓ | Sam Pullen | University of Stanford (online) | spullen@stanford.edu  |
| ✓ | Allen Cleveland | USCG (online) | Allen.Cleveland@uscg.mil |
| ✓ | Hui Liu | Wuhan Navigation & LBS Inc. | liuhui@wnlbs.com |
| ✓ | Leandro D’Orazio | (online) |  |

**APPENDIX 2: SC-134 Working Groups**

|  |  |  |
| --- | --- | --- |
| **WORKING GROUP (WG)** | **WG CHAIR** | **EMAIL ADDRESS** |
| Automotive | Kerry Greer | Kerry.Greer@globalstar.com |
| Rail | Salvatore Sabina | Salvatore.Sabina@ansaldo-sts.com |
| Other Applications (not automotive or rail) | Roberto Capua | rcapua@sogei.it |
| Harmonization of Requirements and Metrics | Roberto Capua | rcapua@sogei.it |

TOP

**APPENDIX 3: SC-134 Open Action Items as of June 22, 2018**

| **Action Item** | **Description** | **Responsibility** | **Review Date** |
| --- | --- | --- | --- |
| SC-134-008 | Kendall will contact BoD about the name change to this committee. | Kendall Ferguson | July 2018 |
| SC-134-007 | Kendall will work on getting a conference room and remote access for the next meeting in Frankfurt, October 15-16. | Kendall Ferguson | July 2018 |
| SC-134-004 | ISO has already dependent “Smart City” standards/references that might be used in the formulation of this group’s work. More information to be gathered. | by Dr. Mireille Elhajj (Imperial College London) | October 2018 |

TOP

**APPENDIX 4: SC-134 Closed Action Items as of June 22, 2018**

| **Action Item** | **Description** | **Responsibility** | **Review Date** |
| --- | --- | --- | --- |
|  |  |  |  |
| ~~SC-134-006~~ | ~~Joe Sass will send out a group notice about the formation of the four working groups.~~ | ~~Joe Sass~~ | ~~June 2018~~ |
| ~~SC-134-005~~ | ~~Roberto has agreed to lead an effort with members that are interested in creating an initial work plan for the committee. A general mailing will be sent to all parties that have expressed any interest asking for ideas, inputs and recommendations to create a work plan.~~~~Decided to leave this action up to the individual working group chairs. Thus Roberto does not need to do this.~~ | ~~Roberto Capua~~ | ~~September 2018~~ |
| ~~SC-134-003~~ | ~~Agenda for kick-off plenary meeting~~ | ~~Kendall Ferguson, Roberto Capua, and Joe Sass~~ | ~~June 2018~~ |
| ~~SC-134-002~~ | ~~Establish an RTCM SC-134 papers page and post SC-134 TOR to that page.~~ | ~~Bob Markle (RTCM President)~~ | ~~June 2018~~ |
| ~~SC-134-001~~ | ~~Send RTCM Members SC-134 announcement letter.~~ | ~~Bob Markle (RTCM President)~~ | ~~June 2018~~ |
|  |  |  |  |